THE EFFECT OF LUMBRICIDAE ON SOIL MICROORGANISMS

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I. — INTRODUCTION

Many authors have shown that the coproliths of Lumbricidae contain a considerably higher amount of microorganisms than the surrounding soil (DAY, 1950 ; ZRAZHEVSKI, 1957 ; KOZLOVSKAJA and ZHDANNIKOVA, 1962 ; PONOMAREVA, 1962 ; GHILAROV, 1963 ; WENT, 1963 ; JEANSON LUUSINANG, 1963).

The aim of our work was to elucidate the effect of Lumbricidae on the densities of microorganisms in relation to the numbers of earthworms, the different soil properties as well as the diverse application and fertilization of the soil in question.

II. — METHODS

The effect of Lumbricidae on the amount of soil microorganisms was investigated in the vegetative pots (made of plastic material 5 litres in volume, 18 cm in diameter and 19 cm in height). The following soils were used : 1. The soil K — soddy gleyish clay loam, pH 6.9 + humus 7,2 per cent (the volume of soil in a pot being 4.3 kg) ; 2. The soil V — soddy podzolic sandy loam, pH 5.3 + humus 2.4 per cent (the volume of soil in a pot making up 5.0 kg). Our experiments had 4 series :

1. soil without plants,
2. soil with the plants (barley),
3. soil fertilized by rye straw (60 g in a vegetative pot, the straw being put 5 cm above the bottom),
4. soil fertilized the same as mentioned above but the straw laid 5 cm below the surface.

All the series had 3 replications and 5 variants with the different numbers of Lumbricidae (*Allolobophora caliginosa* f. *typica* SAV.) :

1. control (no earthworms),
2. 8 earthworms,
3. 16 earthworms,
4. 24 earthworms,
5. 32 earthworms.

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(1) En l'absence des auteurs cette communication a été présentée par M. B. BOUCHÉ.

Experiments were begun on the 1st of May 1969. The microorganisms were investigated in July-October transferring them from the soil (by the serial dilution technique) on 3 agarized media : 1. meat-peptone agar (MPA) ; 2. starch ammonia agar (KAA) and 3. brewer's mash agar (BMA). The numbers of microorganisms which are presented here were counted for 1 g of absolutely dry soil.

III. — RESULTS

It was established that Lumbricidae had a positive effect on the development of soil microorganisms, but the effect was different on the separate groups of microorganisms. In some types of soil the microorganisms increased more distinctly while in others the presence of Lumbricidae had a less marked influence on the microorganisms. Obviously this fact may be accounted for by the physical and chemical properties of the soil in question as well as the numbers of Lumbricidae present in it.

It was ascertained that the densities of microorganisms were different in the soils K and V. In the soil K the densities of microorganisms grown on the medium MPA reached 16-8 5000 specimens per gram while the corresponding figures of microorganisms in the soil V were 14.0-53.5 thousands ; the densities of microorganisms grown on the medium SAA were less varied in both types of soil, namely 160.0-408.8 thousands and 82.0-494.0 thousands. The fungi grown on the medium BMA were on the contrary always more numerous in the soil V (6.0-37.5 thousands) than in the soil K (2.0-15.9 thousands).

In all the 4 series of the soil K, i. e. in the samples without plants, with the plants and those fertilized by straw, the densities of the microorganisms have differed but slightly. In the soil V the picture was different — the soil without the plants contained more fungi which were found in the medium BMA and the soil fertilized by straw lying at the bottom had in the medium SAA more microorganisms using mineral nitrogen than the corresponding figures of the remaining samples (fig. 1, A, B).

It was established that the effect of Lumbricidae on the densities of microorganisms was higher in the soil K than in the soil V. The only exception was the microorganisms using mineral nitrogen and which were grown on the medium SAA (3rd series, fig. 1, B).

The effect of Lumbricidae on the microorganisms depends on the application of the soil and its fertilization. More accentuated is the effect of Lumbricidae in the soil without the plants and in the soil fertilized by straw at the bottom, less marked, the effect in the soil fertilized by straw near the surface and the least effect of Lumbricidae was ascertained in the soil with the plants. When there was a slighter number of earthworms (8 ; 16) in the soil with the plants the microorganisms were found in some of the variants to be less abundant than in the control samples (fig. 1, A, B and fig. 2).

The data of investigations have shown that the effect of Lumbricidae is not the same on the separate groups of microorganisms. The higher effect of Lumbricidae on the amount of microorganisms was established when the latter were grown on the medium MPA where bacteria dominated ; the densities of those microorganisms have increased in the separate soils and variants with 32 earthworms as follows : the soil K 166.1-534.3 p. 100, the soil V 148.7-382.1 p. 100. The effect of Lumbricidae on the microorganisms was marked when the latter had been grown in the medium

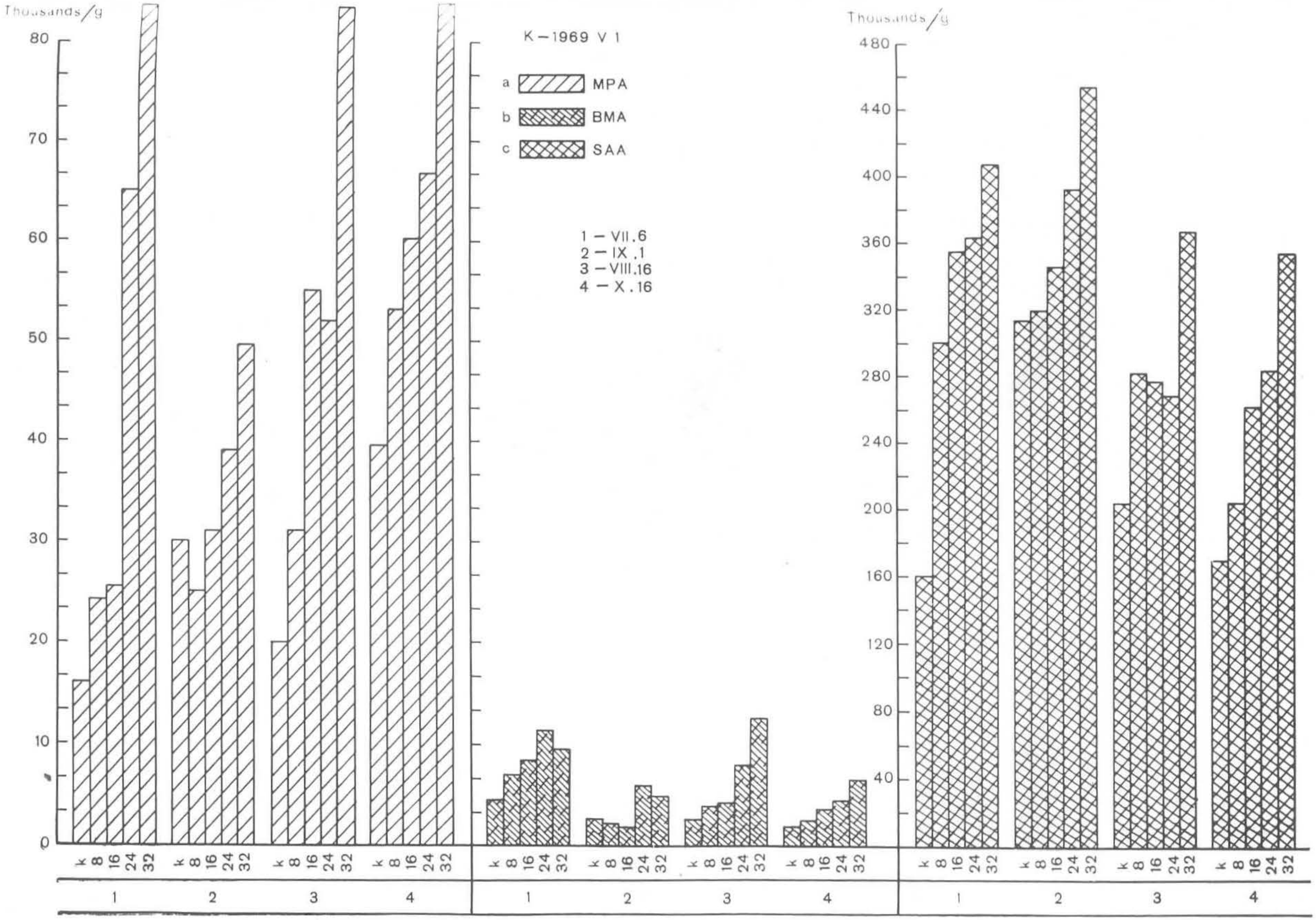
Thousands/g
80
70
60
50
40
30
20
10
0
K–1969 V 1
a ▨ MPA
b ▨ BMA
c ▨ SAA
1 – VII.6
2 – IX.1
3 – VIII.16
4 – X.16
Thousands/g
480
440
400
360
320
280
240
200
160
120
80
40
k 8 16 24 32
1
2
3
4

Fig. 1 A

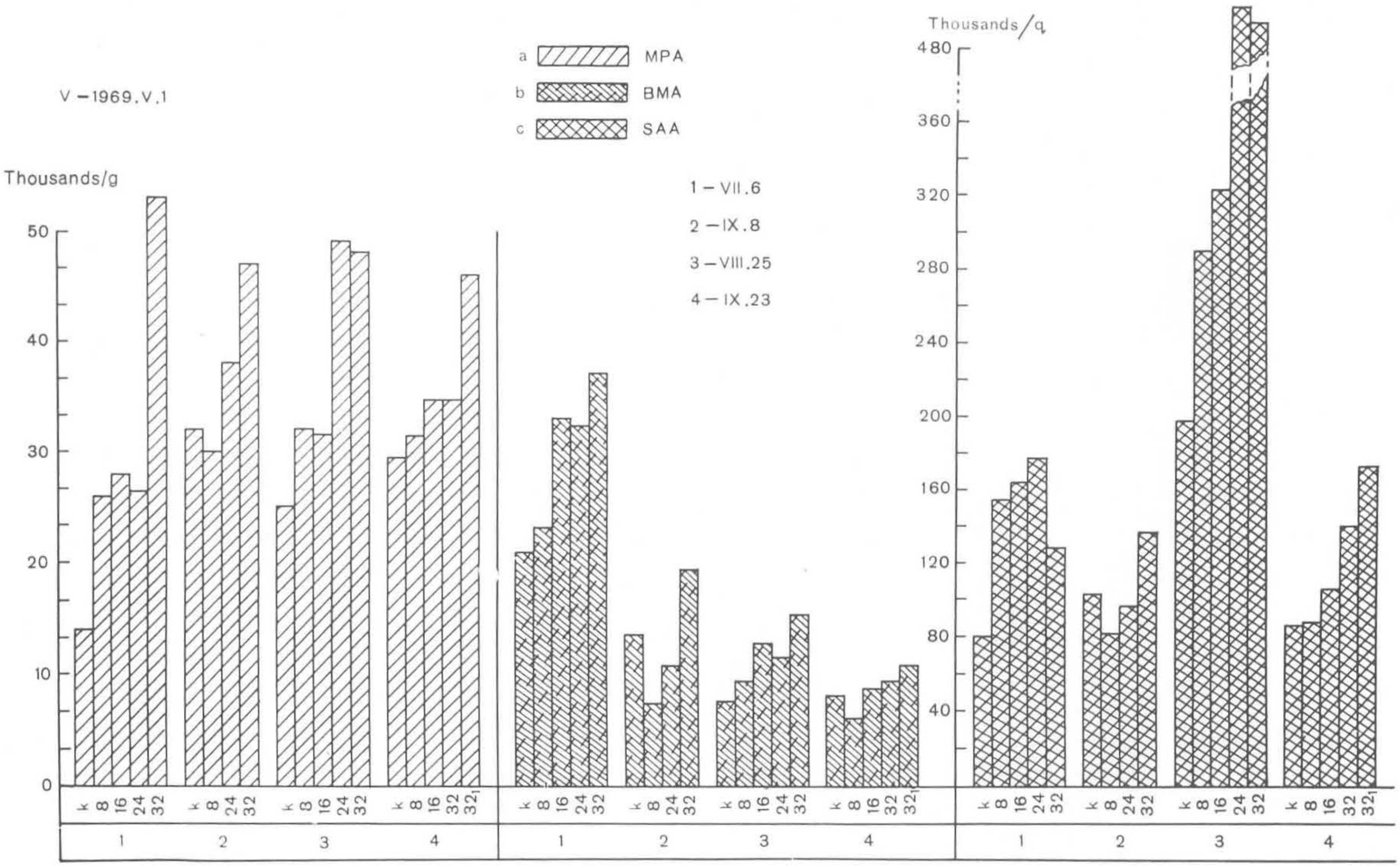

FIG. 1. B — *The effect of Lumbricidae on the densities of microorganisms in the various soils:* A *in the soil* K*;* B *in the soil* V

the 1st of May 1969 — the beginning of experiments ; the 6th of July, the 25th of August, etc. — the dates of investigations of microorganisms : 1 — in the soil without the plants ; 2 — in the soil with the plants ; 3 — in the soil fertilized by straw near the bottom ; 4 — in the soil fertilized by w near the surface ; *a*, *b*, *c* — the media ; 32_1 — the microorganisms in the coprolith-straw layer.

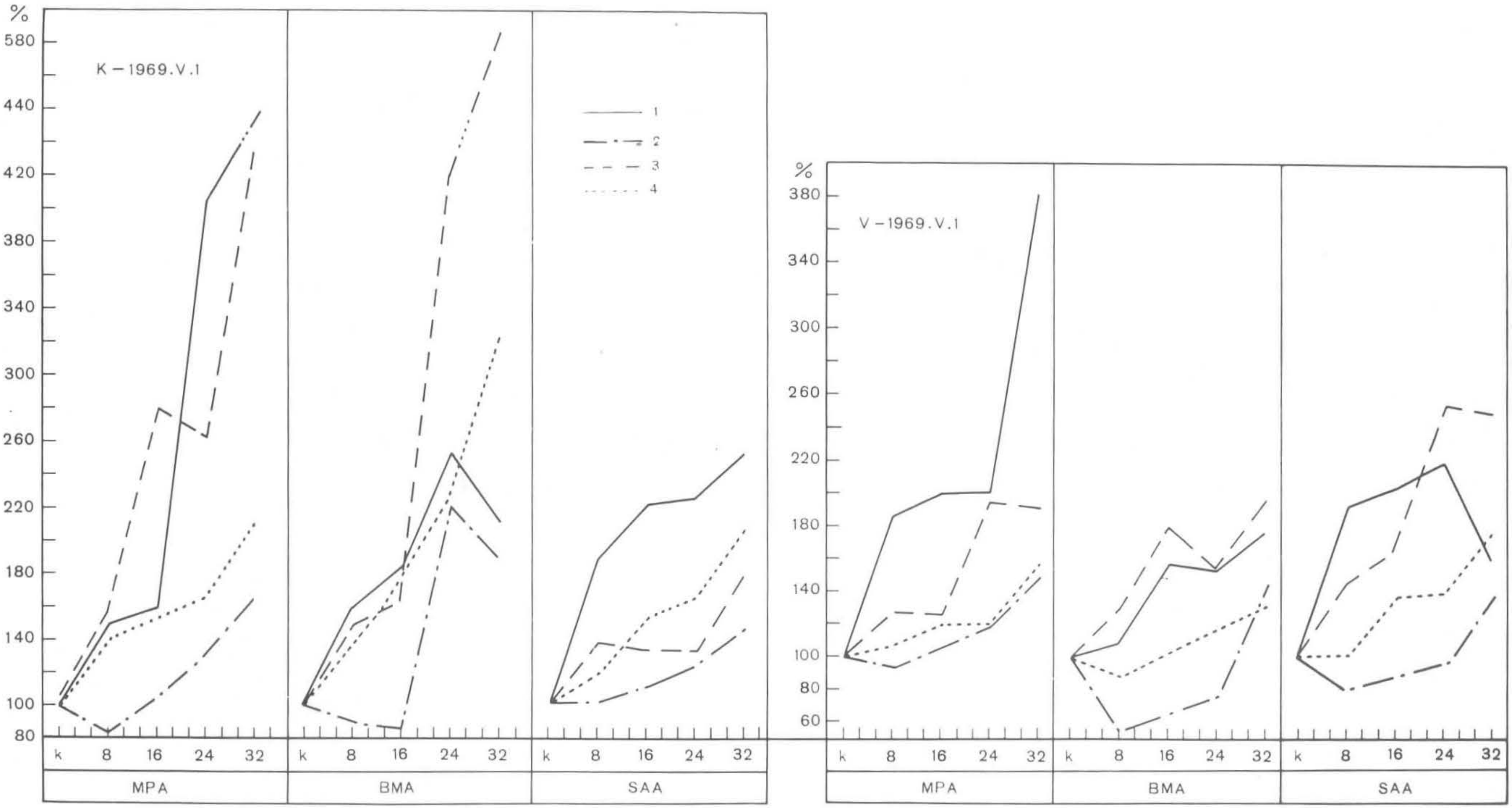

FIG. 2. — *The effect of Lumbricidae on the densities of microorganisms* (in percentage). *Explanations the same as in figure* 1

BMA where fungi dominated. For example, the variants with 32 earthworms contained increased densities of microorganisms in the following way : the soil K contained 189.2-588.0 p. 100, the soil V 143.3-197.3 p. 100 more microorganisms than the control. The effect of Lumbricidae was less marked on the microorganisms using mineral nitrogen which were grown on the medium SAA with actinomycetes dominating in it, namely the soil K contained 145.1-254.9 p. 100 and the soil V 137.0-250.5 p. 100 more microorganisms than the control (fig. 2).

It is evident that the numbers of Lumbricidae have a great significance for the densities of soil microorganisms. According to our data of investigations the densities of microorganisms in almost all the cases were directly related to the numbers of Lumbricidae (fig. 1, A, B). The densities of microorganisms in the variants with 24 and 32 earthworms were up to 5 times higher than the corresponding figures of the control. For instance in the soil K without the plants the variants with 8, 16, 24 and 32 earthworms had 150.0, 159.3, 406.0 and 534.3 p. 100 microorganisms increase respectively ; the soil V fertilized by straw near the surface having 8, 16, 24 and 32 earthworms had increased their microorganisms by 101.7 ; 135.1 ; 138.9 and 172.8 p. 100 respectively (fig. 2).

It is to be assumed that the different effect of Lumbricidae on the microorganisms is conditioned by the different survival of earthworms in the separate soil samples (fig. 3). After having analyzed our data on the survival of earthworms in

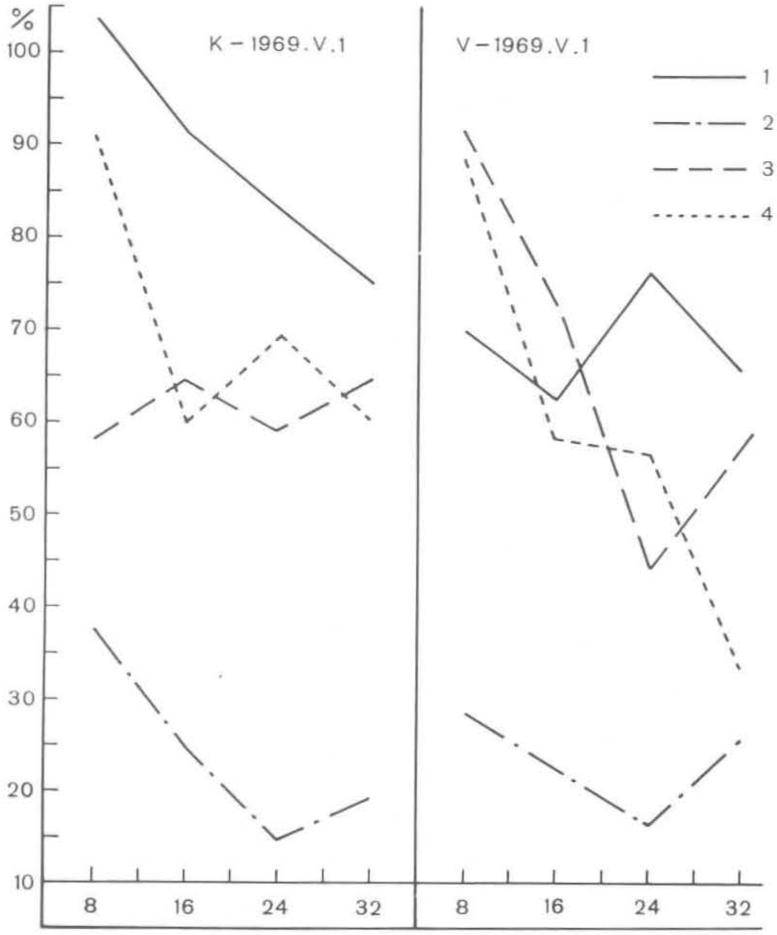

FIG. 3. — *The survival of Lumbricidae in the various soils of the vegetative pots. Explanations the same as in figure 1*

the soil samples we noticed that the densities of microorganisms were higher in those samples where the numbers of Lumbricidae remained more elevated during experiments. The worst survival of Lumbricidae was observed in the soils with plants (the soil K 15.0-37.5 p. 100, the soil V 16.6-28.5 p. 100), better survival was noticed in the soils fertilized by straw near the surface (the soil K 60.0-91.0 p. 100 ; the soil V 33.3-87.5 p. 100) ; much better the earthworms survived in the soil without the plants (the soil K 75.0-103.7 p. 100 ; the soil V 62.5-76.2 p. 100) and in that fertilized by straw near the bottom (the soil K 57.5-75.0 p. 100 ; the soil V 44.1-91.2 p. 100). The initial number of Lumbricidae in the soil is also of importance for their ensuing survival. For the most part the survival of Lumbricidae was better when they were fewer (8 ; 16) than in those cases when their numbers were high (24 ; 32 earthworms in a pot).

The marked effect of Lumbricidae on the microorganisms in the soils fertilized by straw is conditioned by the activity of earthworms and their abundant production of coproliths which are deposited in the soil surrounding the earthworms. There is a big accumulation of coproliths in the straw used as a fertilizer (200-500 g). The authors cited at the beginning of our paper have indicated that the densities of microorganisms in the coproliths are several times higher than the corresponding figures of microorganisms in the surrounding soil. According to our investigations (the soil V, the 4th series, the variant marked as « 32_1 », fig. 1, B), the densities of microorganisms in the coproliths found in the straw layer were higher only by 16.5-35.1 p. 100 in comparison with the corresponding numbers of microorganisms in the surrounding soil.

Although the survival of earthworms in the soil with the plants was worse in comparison with other samples and the effect of Lumbricidae on the microorganisms less accentuated, the barley grain crop in the experimental variants increased accordingly to the numbers of earthworms present in the soil (fig. 4).

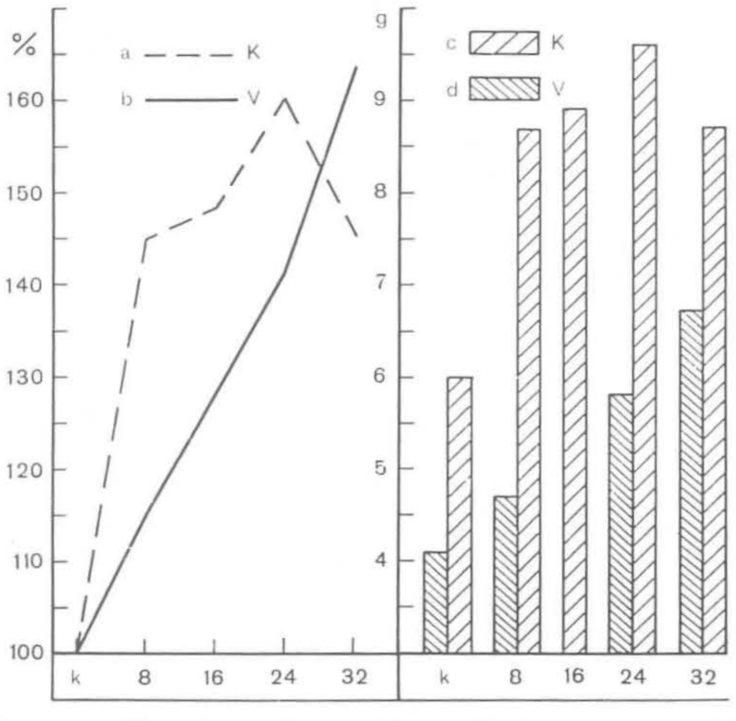

FIG. 4. — *The effect of Lumbricidae on the barley grain crop*

IV. — CONCLUSIONS

The activity of Lumbricidae has a positive effect on the microorganisms of the soil. As a consequence of Lumbricidae activity the densities of soil microorganisms can increase up to 5 times. The effect of Lumbricidae on the soil microorganisms is more accentuated in the soil without the plants and in the soil fertilized by straw while it is less marked in the soil with the plants.

RÉSUMÉ

EFFET DES *LUMBRICIDAE* SUR LES MICROORGANISMES DU SOL

L'activité biologique des *Lumbricidae* a un effet positif sur le développement des microorganismes du sol. Cette activité a pour conséquence un accroissement de la densité des microorganismes du sol, allant jusqu'à la quintupler. L'action des *Lumbricidae* sur les microorganismes du sol est plus accentuée dans les sols dépourvus de végétation et dans les sols fertilisés par un apport de paille, alors qu'elle est moins marquée dans un sol planté.

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